A Study on Self Compacting Concrete by the Application of Silica Fume

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ABSTRACT

Self-consolidating concrete (SCC) is a highly flowable, yet stable that can spread readily into place and fill the form work without any consolidation and without undergoing any significant separation. In general SCC result in reduced construction time and reduced noise pollution. SCC has been produced using high power content, using viscosity modifying agents or combination of the two. This study mainly deals about the principles of properties, present status and scope of **self-compaction of concrete by the application of silica fumes** in modern world of the concrete technology. Concrete in an indispensable material in the field of construction. Concrete involves huge consumption of cement cost of which is in the increasing trend in the modern days. Hence it is worthwhile to find a suitable substitute which replace cement by a sizable quantity.

Keywords: Silica fume, cement, viscosity modifying admixtures, super plasticizers, physical properties, concrete properties, self compacting concrete, workability, fresh concrete, hardened concrete.

I. INTRODUCTION (Font-Cambria, Bold, Font Size -12)

Concrete is a highly heterogeneous material produced by mixture of finely powdered cement, aggregates of various sizes and water with inherent physical, chemical and mechanical properties. SCC is made from the same basic constituents as conventional concrete but with the addition of a viscosity modifying admixture and high levels of superplasticising admixtures to impart high workability. The cement (powder) content of SCC is relatively high. The ratio of fine to coarse aggregates is more in self-compacting concrete. Fine fillers such as fly ash, silica fume, slag, metakaoline, marble dust and rice husk ash may be used in addition to cement to increase the paste content.

Silica fume was first discovered in Norway in 1947 when the environmental controls started the filtering of the exhaust gases from furnaces. The main portion of these fumes was a finely composed of a high percentage of silicon dioxide.

Silica fume consists of the fine particles with specific surface about six times of cement because its particles are very finer than cement particles. Hence, it has been found that when silica fume mixes with concrete the minute pore spaces decreases. Silica fume is pozzolanic, because it is reactive, like volcanic ash. Its effects are related to the strength, modulus, ductility, sound absorption, vibration damping capacity, abrasion resistance, air void content, bonding strength with reinforcing steel, shrinkage, permeability, chemical attack resistance, alkali-silica reactivity reduction, creep rate, corrosion resistance of embedded steel reinforcement, freeze-thaw durability, coefficient of thermal expansion (CTE), specific heat, defect dynamics, thermal conductivity, dielectric constant, and degree of fibre dispersion in mixes containing short microfibers

II. MATERIALS AND METHODS

Cement: All types of cement are suitable for SCC.In this study 53 grade cement is used.

Aggregates: washed aggregates are used for better result. The shape and particle size distribution of the aggregate is very important and affects the packing and voids content

Water: Ordinary potable water can be used for this work.

Chemical Admixture: Superplasticisers or high range water reducing admixtures (HRWRA) are an essential component of SCC. Viscosity modifying admixtures (VMA) may also be used to help reduce segregation and the sensitivity of the mix due to variations in other constituents, especially to moisture content.

Silica fume: It is the mineral admixture, which contains extremely small and spheroid particles of siliceous matter removed from outgoing gases by bag filters in the siliceous metal or ferrosilicon alloy producing plants.

Mix Design Procedure: There is no standard method for SCC mix design and many academic institutions; admixture, ready-mixed, pre cast and contracting companies have developed their own mix proportioning methods. Okamura's method, based on EFNARC specifications, was used for the study. Based on this method a preliminary SCC mix was designed.

Test on Fresh Concrete: In fresh concrete workability test like slump test, V funnel test and U box test are done to determine filling ability and passing ability and also test to determine setting time.

Test on Hardened Concrete: 150 mmx150mmx150mmcubes is prepared to measure the compressive strength of hardened concrete at 7 day.100mm x 100mm x 500mm size prisms for the determination of flexural strength of different mixes.The 150mm diameter and 300mm long cylinder specimens were also prepared for all the mixes, for the determination of compressive strength and splitting tensile strength.

III. TESTS RESULTS IN FRESH CONCRETE

Workability test:

Mix	Slump flow test (mm)	T_{50} Slump flow (s)	V-funnel flow test (s)	V-funnel T_5 minutes test (s)	U- box value (mm)	Reference
MSF 0	782	2	6	+1	15	SCC
MSF 2	740	2	9	+1	20	SCC
MSF 4	705	3	10	+2	28	SCC
MSF 6	710	3	10	+3	30	SCC
MSF 8	650	5	16	+6	35	NOT SCC

Table 1:Fresh Properties of SCC using Silica fume

Initial Setting time:

Mix	Setting time in hours
MSF 0	22.5
MSF 2	23
MSF 4	23
MSF 6	22.1

Table 1: Initial Setting time of SCC using Silica fume

IV. TESTS RESULTS IN HARDENED CONCRETE

Compressive Strength: Six cube samples each for various percentage of cement replaced by silica fume were tested to determine the 7 day and 28 day compressive strength using a 3000kN Compression Testing Machine

Mix	Average cube compressive strength (N/mm^2)	
	7 days	28 days
MSF 0	26.66	33.77
MSF 2	27.18	34.74
MSF 4	28.27	35.74
MSF 6	29.29	37.92

Table 3: Cube Compressive strength of SCC with Silica Fume

Mix	Cylinder compressive strength (N/mm^2)
MSF 0	22.27
MSF 2	23.96
MSF 4	26.79
MSF 6	29.44

Table 4: Cylinder Compressive strength of SCC with Silica Fume

Split Tensile Strength:

Mix	Splitting tensile strength (N/mm^2)
MSF 0	3.13
MSF 2	3.25
MSF 4	3.53
MSF 6	3.63

Table 5: Split tensile strength of SCC with Silica Fume

Flexural Strength: Three beams were used to determine flexural strength

Mix	**Flexural strength (N/mm^2)**
MSF 0	2.63
MSF 2	2.89
MSF 4	3.74
MSF 6	4.05

Table 6: Flexural strength in SCC with Silica Fume

Modulus of Elasticity:

Mix	**Modulus of elasticity (N/mm^2)**
MSF 0	2.32 x 10^4
MSF 2	2.35 x 10^4
MSF 4	2.39 x 10^4
MSF 6	2.46 x 10^4

Table 7: Modulus of Elasticity in SCC with Silica Fume

V. DISCUSSION OF RESULT

Workability :

It is observed that as the percentage of mineral admixtures increases in the design SCC mix, workability decreases for all mineral admixtures and self-compatibility was retained up to 9%, 6%, 20% of cement replaced by Silica fume

Hardened properties :Hardened properties like cube compressive strength, cylinder compressive strength, splitting tensile strength, flexural strength and modulus of elasticity of the design SCC mix and mixes with various percentages of replacement of cement by mineral admixtures were studied

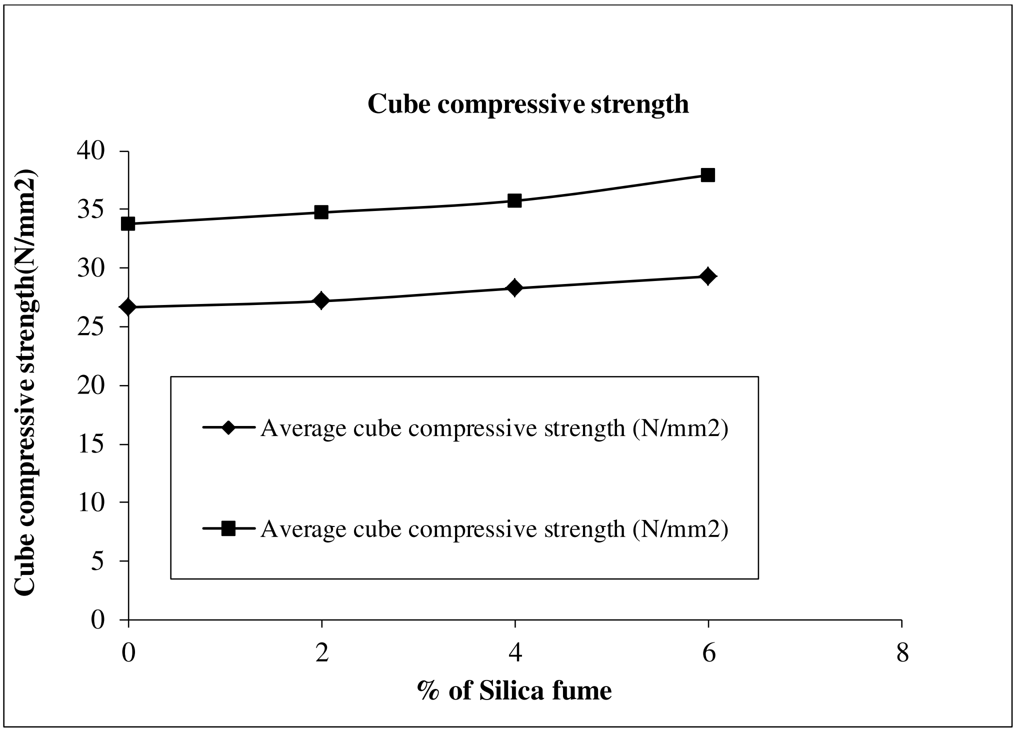

Fig1 : Effect of Silica Fume in Cube compressive Strength

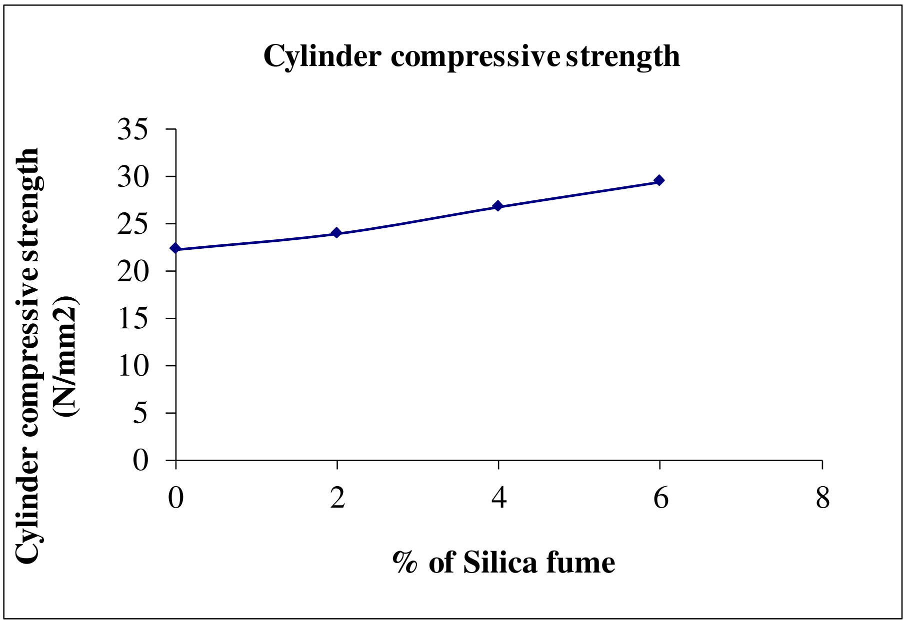

Fig2: Effect of Silica Fume in Cylinder compressive Strength

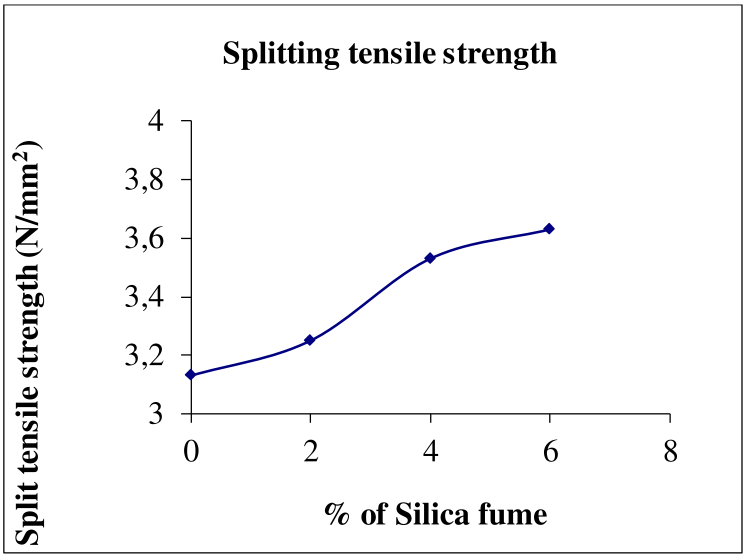

Fig 3: Effect of Silica Fume in Split Tensile Strength of SCC

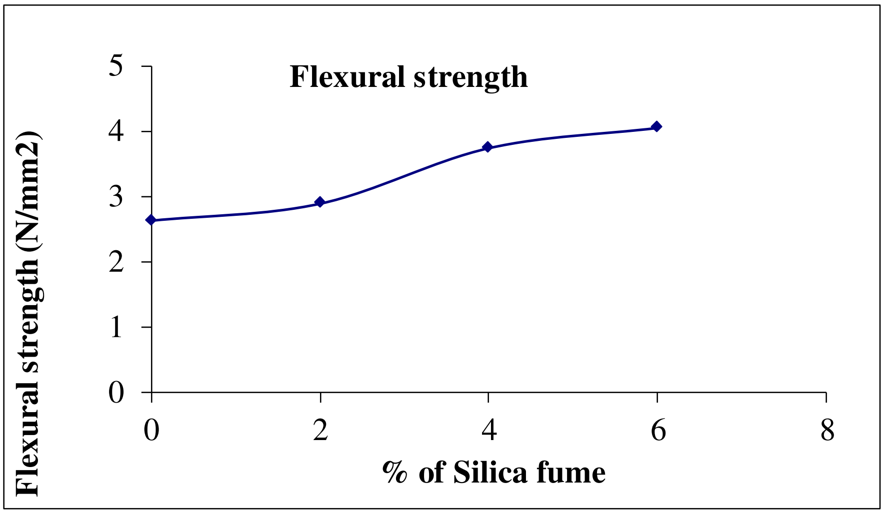

Fig 4: Effect of Silica Fume in Flexural Strength of SCC

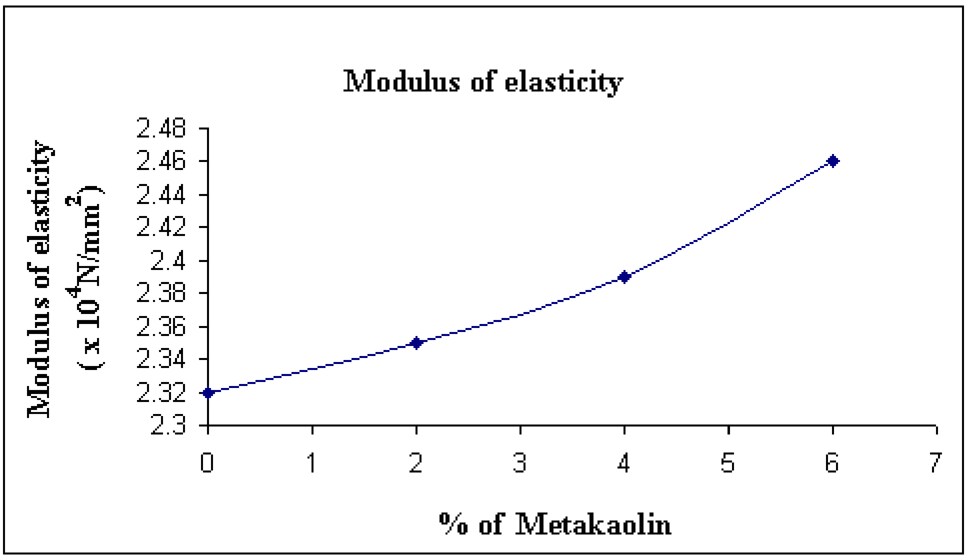

Fig 5: Effect of Silica Fume in Modulus of Elasticity of SCC

VI. CONCLUSION

- SCC mix was proportioned by conducting experimental trials in the laboratory,considering the guidelines evolved by the various researchers and EFNARC specifications.
- The characteristics of SCC mix was achieved by using high powder content, optimizing water to powder ratio, a high volume of fine aggregate as compared to coarse aggregate.
- The smaller size aggregates give better workability.
- About 30 % cement content is replaced by supplementary cementing material like silica fume and therefore the ill effects of excessive cement in the concrete like thermal effects and bleaching of calcium hydroxide can be reduced thereby increasing the durability of the structure. The cost of SCC can also be considerably reduced.
- The use of good quality superplasticier is essential to get SCC mix of adequate workability. VMA is needed in the SCC mix to avoid bleeding and segregation of the concrete mixture.
- Effect on mineral admixture like fly ash, on fresh properties, hardened properties and durability of SCC were studied.

VII. REFERENCES

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